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ABSTRACT

This paper, part of an evaluation of the early intervention project at the Frank Porter Graham Child Development Center, deals primarily with results of the Bayley Mental Development Index (MDI). The MDI was administered to experimental and control infants from lower socioeconomic background at 6, 12 and 18 months of age. Results (discussed in detail) indicate that the positive effects of early intervention can clearly be seen by the middle of the second year of life. Disadvantaged infants, as a group, tested within the normal limits at 6 and at 12 months. The experimental group maintained this level at 18 months, but the control group showed a sharp decline in the second year. Also discussed were features in the test performances which helped account for the differences in tested intellectual levels between the disadvantaged children in the intervention program and those who were not. (MS)

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The Effects of Early Intervention on Intellectual Development

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Paper presented at the Society for Research in Child Development in New Orleans, 1977.

The Effects of Early Intervention
on Intellectual Development

Frances Campbell & Craig Ramey
Frank Porter Graham Child Development Center

The early intervention project at the Frank Porter Graham Center, like other such programs, relies on standardized tests of intellectual development as a primary outcome measure. Standardized tests provide an objective relative to which the intellectual development of our children may be measured. Moreover, such test scores allow us to compare the outcome of our program with outcomes of other, similar projects around the country, using a common frame of reference.

The aim of our intervention program has been the prevention of a decline in intellectual level in our experimental group of disadvantaged children. To date, we have longitudinal test data on 54 children, 28 in the Experimental group and 26 in the Control group. The Bayley Scales of Infant Development were given to the infants at 6, 12, and 18 months of age. This paper deals only with the results of the Bayley Mental Development Index, or MDI. The Stanford-Binet Intelligence Scale was administered when the children were 24 and 36 months old. The IQ's to be reported are based upon the 1972 norms for the test and are therefore about 10 points lower than they would have been had we used the previous norms. All children were tested on all occasions with their mothers present in a room equally unfamiliar to both groups.

Insert Figure 1 about here

Figure 1 shows the mean Bayley MDI scores at 6, 12, and 18 months and the mean Binet IQ's at 24 and 36 months for the children in the Experimental and Control groups. Two things are immediately apparent: First, consistent with previous reports by Bayley (1965), our socioeconomically disadvantaged infants

scored within the average range during the first year of life; second, the Experimental group maintained this level at 18 months but the Control group showed a sharp decline in the second year. These results, plus other test results as well, are summarized in Table 1.

Insert Table 1 about here

The Bayley MDI scores were analyzed using a 2 (groups) x 3 (occasions) multivariate analysis of variance of repeated measures design in which group assignment and age at testing were independent variables and Bayley MDI was the deperdent variable. The results of this analysis are summarized in Table 2. There was a significant main effect for age at testing and a significant group x age interaction effect. Reanalyzing the age effect for the Experimental and Control groups separately revealed that there was no change related to age in the Experimental group but a significant age effect in the Control group. T-tests of the means showed no change from 6 to 12 months for either group, and a significant change from 12 to 18 months for the Control group only. These figures are given in Table 3. The Experimental group did not change over time. The Control group dropped significantly from the 12 month to the 18 month test.

Insert Tables 2 and 3 about here

We also obtained Bayley scores at ages 6 and 18 months from 14 infants identified in a random sample of the local community. The families in this sample were predominantly middle class and thus their infants form a contrast group for the disadvantaged infants making up the Experimental and Control groups.

Insert Figure 2 about here

The comparison of the results of these Bayley tests are shown in Figure 2. Separate analyses of variance for the MDI scores at 6 and 18 months showed no between-group differences at 6 months but significant between group differences at 18 months. These results are summarized in Table 4. Multiple range contrasts using the Scheffé procedure showed that the mean for the Control group differed significantly from the means of the Experimental group and the general population sample (GPS), which did not differ from each other. Inspection of the means showed that the Control group's scores had dropped 13 points from the 6 to 18 month testing time. The essential finding from the infant tests, then, was that the disadvantaged infants, as a group, tested within normal limits at 6 and at 12 months. Infants in the Experimental group maintained that mean level of cognitive functioning through the first half of the second year at which time they did not differ from an advantaged comparison group, the GPS. In contrast, by 18 months of age, disadvantaged infants not in the intervention program showed a significant drop in tested developmental level.

Insert Table 4 about here

The Experimental and Control children have been further tested using the Stanford-Binet Intelligence Scale at 24 and 36 months. The results of these tests are in Table 5, as well as in Figure 1. We thought it best not to combine the Bayley and Binet results into one overall group by time analysis since it would be difficult to interpret changes over time which involved using different tests based on different normative populations. We compared the two groups' mean IQ's at 24 and 36 months using t-tests and found reliable differences

in mean IQ at both ages for the two groups. At 24 months the Experimental group showed a 10 point advantage over the Control group in mean IQ; this difference had grown to 15 points at 36 months. Table 6 shows t-tests for related means. Neither the Experimental nor the Control group means changed significantly over time. Rather, they maintained their relative positions over the year. These figures are given in Table 6.

Insert Tables 5 and 6 about here

Taken together, the results of the standardized tests showed that the positive effects of early intervention can be clearly seen by the middle of the second year of life. Without intervention, a decline in tested intellectual level was apparent by 18 months of age, and although the children in the Control group continued to decline, the rate was never again so rapid as it appeared to be between the ages of 12 and 18 months. The period between the ages of 12 and 24 months appeared to be an important age in the intellectual development of the disadvantaged child.

What features in the test performances themselves helped to account for the differences in tested intellectual levels between the disadvantaged children in the intervention program and those who were not? One obvious question was whether the children in the day care program behaved differently in the testing situation from children not in systematic daycare. Child behavior ratings were made by the testers after each examination using the Infant Behavior Record of the Bayley Scales or the Kohn and Rosman Test Behavior Inventory (1973) for older children. At 18 months the Experimental children were rated as more cooperative and as less fearful than the Control children. At 36 months the only reliable difference was that the Control children were rated as more anxious and withdrawn. Differences in ability to be at ease and to relate to unfamiliar adults

might be partly responsible for the Control children's relatively poor showing on the tests.

We also examined the individual test items to see whether the two groups of children showed differential passing rates on particular classes of items. Disadvantaged children begin to show deficits at the age when spoken language is beginning to develop and at the age when the tests begin to require more language competency. We hypothesized, therefore, that children in the intervention program might have a language advantage which would account for their superior test performance.

We classified the 77 Bayley items given at 18 months into four categories labeled: language, perceptual-motor, problem-solving, and imitation. We then computed the percentage of children passing each item separately for Experimental and Control groups. Arbitrarily, we required a 20% minimum difference in the percentage passing an item to regard that item as discriminating between groups. With this criterion, we found 11 Bayley items on which the Experimental children surpassed the Control children. Five of the 11 items were language items; the other six were perceptual-motor items. No items in either the problem-solving or imitation categories reached the criterion of difference we set. On no item at all did the Control group reach the criterion to exceed the Experimental group.

Similarly, the Binet items were examined for group differences. Applying a like system of classification, we labeled 26 of the 42 items administered at 36 months as language items, 13 as perceptual-motor and 3 as mixed. Of the 42 Binet items, 17 discriminated between the two groups by 20% or better. Of these 17, 10 were language items and 7 were perceptual-motor items. On 17 of the 17 items, the Experimental group exceeded the Control group. On one item, repeating 2 digits, the Control children exceeded the Experimental children.

Admittedly, the foregoing is rather informal, but it suggests two points. First, the Experimental children did appear to have a language advantage over

the Control group and this may well be one reason why their tested developmental level remained more stable over an age range when standardized intelligence tests grow increasinly dependent upon language competency. Second, and somewhat less expected, the Experimental group of children also show an advantage on non-language items involving visual-motor skills.

The language advantage seen in the Experimental children at 36 months is already apparent at 30 months of age when we administer the Verbal Scale from the McCarthy Scales of Children's Abilities. In searching for a brief, well-standardized measure of language development, we chose the Verbal Scale of the McCarthy because it measures both receptive and expressive language and provides good norms. Each Scale on the McCarthy permits the conversion of raw scores into Scale Indices with a mean of 50 and a S.D. of 10. At 30 months of age, the Experimental group had a mean Verbal Scale Index of 49, indicating verbal development at a rate which was average for the normative group of the test. The Control group had a mean Verbal Scale Index of 43, 7 points below the mean Scale Index.

In conclusion, the standardized tests show that the intervention program at the Frank Porter Graham Center has indeed had a significant influence on the intellectual development of the disadvantaged children in the Experimental group. Reliable differences in mean intellectual test scores were found for the Experimental and Control groups at every age past 12 months. While the children in the intervention program had a relatively stable level of intellectual development from 6 to 36 months of age, the Control children showed a drop in intellectual development by 18 months of age which persisted and tended to grow greater by age 36 months.

We are, of course, mindful of the fact that standardized intelligence tests have been criticized as being unfair to disadvantaged children, and that poor performance on tests may not truly reflect lack of mental capacity in a disadvantaged

child. We are mindful, too, that we have a responsibility to the children in our Control group. For those Control children who earn two consecutive IQ scores below 70 we call in the parents for consultation and refer them to relevant community agencies if they so desire.

It is well to remind ourselves, too, that not all Control children have shown declines in intellectual level. Nor have we succeeded in preventing some children in the Experimental program from faltering in intellectual growth. On the whole, however, the intervention program has significantly enhanced the children's intellectual and language development.

References

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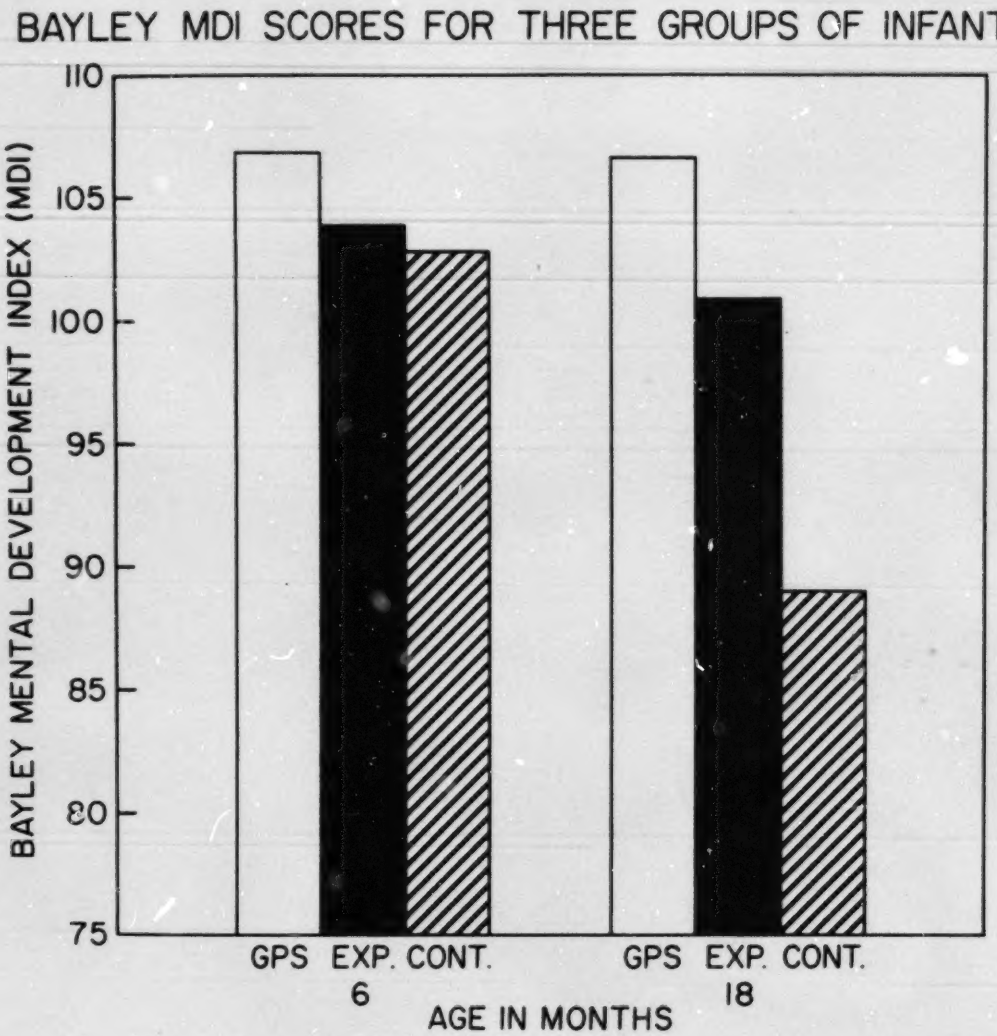
BAYLEY MDI SCORES FOR THREE GROUPS OF INFANTS
BAYLEY MENTAL DEVELOPMENT INDEX (MDI)
110
105
100
95
90
85
80
75
GPS
EXP.
CONT.
GPS
EXP.
CONT.
6
18
AGE IN MONTHS

Figure 1

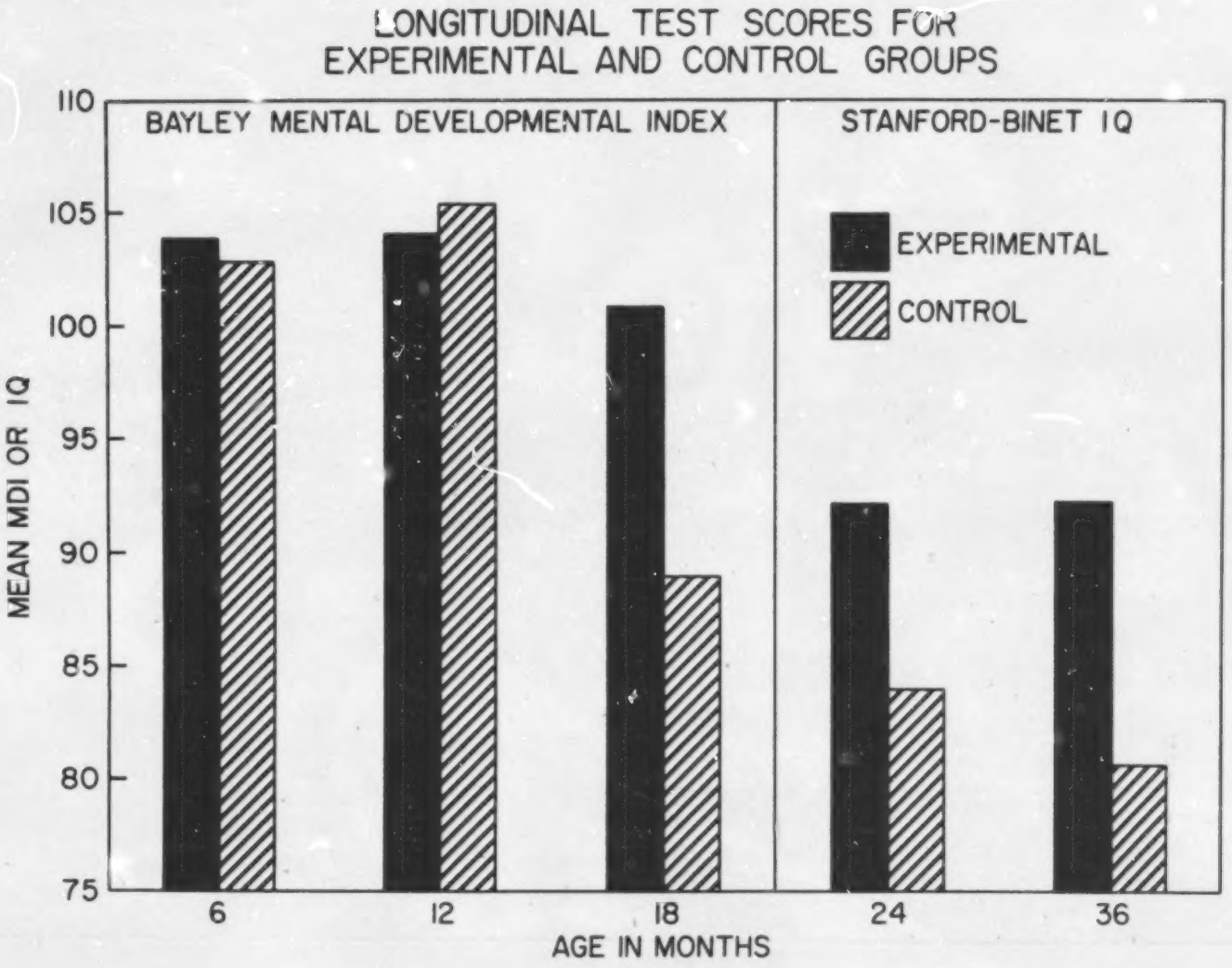
LONGITUDINAL TEST SCORES FOR
EXPERIMENTAL AND CONTROL GROUPS
BAYLEY MENTAL DEVELOPMENTAL INDEX
STANFORD-BINET IQ
EXPERIMENTAL
CONTROL
MEAN MDI OR IQ
110
105
100
95
90
85
80
75
6
12
18
24
36
AGE IN MONTHS

Figure 2

Table 1

Standardized Test Results for Experimental, Control and General Population Groups

Mean Bayley MDI, Stanford-Binet IQ and McCarthy Verbal Scale Index Scores for Experimental, Control and General Population Groups

Test Score	Age (Mos.)	Experimental Group Mean Score	Control Group Mean Score	GPS Group Mean Score
Bayley MDI	6	105.89	102.82	106.93
Bayley MDI	12	106.07	105.39	-
Bayley MDI	18	102.71	89.04	106.57
Stanford-Binet IQ	24	93.68	83.04	-
Stanford-Binet IQ	36	95.68	80.60	-
McCarthy Verbal Scale Index	30	49.22	43.36	-

Table 2

Standardized Test Results for Experimental, Control and General Population Groups

MANOVA Results for Bayley MDI's at 6, 12 and 18 months.

Source	F	df	p
Groups (E or C)	2.03	2,51	N.S.
Age at testing	12.37	2,51	.001
Group x Age	2.25	2,51	.008

Table 3

Standardized Test Results for Experimental, Control and General Population Groups

t-Tests of Mean Differences Over Time for Bayley MDI in E & C Groups

Group	Time Period	t	df	p
E	6-12	-0.55	26	N.S.
	12-18	1.22	27	N.S.
C	6-12	-1.10	27	N.S.
	12-18	5.70	25	.001

Table 4

Standardized Test Results for Experimental, Control and General Population Groups

Analysis of Variance for 6 Month Bayley MDI Score in E, C & GPS Groups

Source	df	Mean Squares	F	p
Between Groups	2	79.12	0.288	N.S.
Within Groups	67	274.33		

Analysis of Variance for 18 Month Bayley MDI Score in E, C & GPS Groups

Source	df	Mean Square	F	p
Between Groups	2	1673.88	5.63	.006
Within Groups	66	397.56		

Multiple Range Test - Scheffé Procedure

Subset 1: C $\overline{X}$ = 89.04
Subset 2: E $\overline{X}$ = 102.71
GPS $\overline{X}$ = 106.57

Table 5

Standardized Test Results for Experimental, Control and General Population Groups

t-Tests of Mean Differences for Stanford-Binet IQ at 24 & 36 Months and McCarthy Verbal Scale Index at 30 Months for E and C Groups

Test	t	df	p
Stanford-Binet 24	3.44	51	.001
Stanford-Binet 36	3.74	51	.001
McCarthy Verbal Scale Index 30	2.50	50	.02

Table 6

Standardized Test Results for Experimental, Control and General Population Groups

Related *t*-Tests of Stanford-Binet IQ's at 24 & 36 Months for E and C Groups

Group	*t*	df	p
E	-0.93	27	N.S.
C	1-62	24	N.S.